Notes on the Life Cycle and Natural History of Butterflies of El Salvador

I A.—*Catonephele numilia esite* (Nymphalidae-Catonephelinae)

Alberto Muyshondt

101 Avenida Norte #322, San Salvador, El Salvador

Received for Publication May 8, 1973

INTRODUCTION

This is the first article of a second series (elsewhere we have presented a first series dealing with the subfamily Charaxinae), describing what my sons and I have found about the life cycle and natural history of butterflies of the Catonephelinae group of the Nymphalidae found in El Salvador, the smallest country of Central America.

It is our understanding that the life cycle of many species of neotropical Rhopalocera is at least incompletely known and therefore they have been classified based exclusively on the adults' morphological characteristics. According to E. B. Ford (1945), "Any classification must take into account as many as possible of the external and internal structures not only of the adult but of the early stages." With this in mind, we undertook the task of rearing from egg to adult as many of the local species as possible, photographing the different stages of the metamorphosis, recording the measures and the time elapsed on each one. Specimens of the early stages have been preserved in alcohol and are sent to museums where they are kept and are available to students of the groups.

A major difficulty has been the determination of the species described, as we are dependent on A. Seitz (ed.), 1924, "Macrolepidoptera of the World." Vol. 5, The American Rhopalocera, 1907–14, a book that is, according to Klots (1960), "replete with errors that cause much confusion." To solve this problem we have requested the valuable assistance of Drs. A. B. Klots and F. D. Rindge of the American Museum of Natural History and L. D. Miller of the Allyn Museum of Entomology, who have kindly identified the material submitted to them.

Acknowledgments: We express our deep obligation to Dr. Alexander B. Klots who, in the course of three years, has given much needed encouragement and guidance from his vast experience in studying butterflies and has taken the time to read this manuscript to help to make it presentable. We are grateful also to Dr. F. D. Rindge who identified the species described and gave valuable counsel. My appreciation also goes to Drs. A. M. Young and S. D. Steinhauser who provided reference material. The senior of the Muyshondt family gives due credit to his sons, in particular, Albert, Jr., and Pierre, for their unfailing enthusiasm in the fieldwork.

In our article on *Prepona omphale octavia* Frühstorfer (Muyshondt 1973 A), we made a rough description of the country, its climatic zones, and other pertinent information, so as to form an understandable picture of the habitat of the species described.

We have observed *Catonephele numilia esite* Felder at altitudes ranging from 500 m. to 1200 m., always in the neighborhood of coffee plantations (that are manmade forests owning to the local technique of planting the coffee under shade trees), mostly between June and November, that is, mostly during the rainy season (May to October).

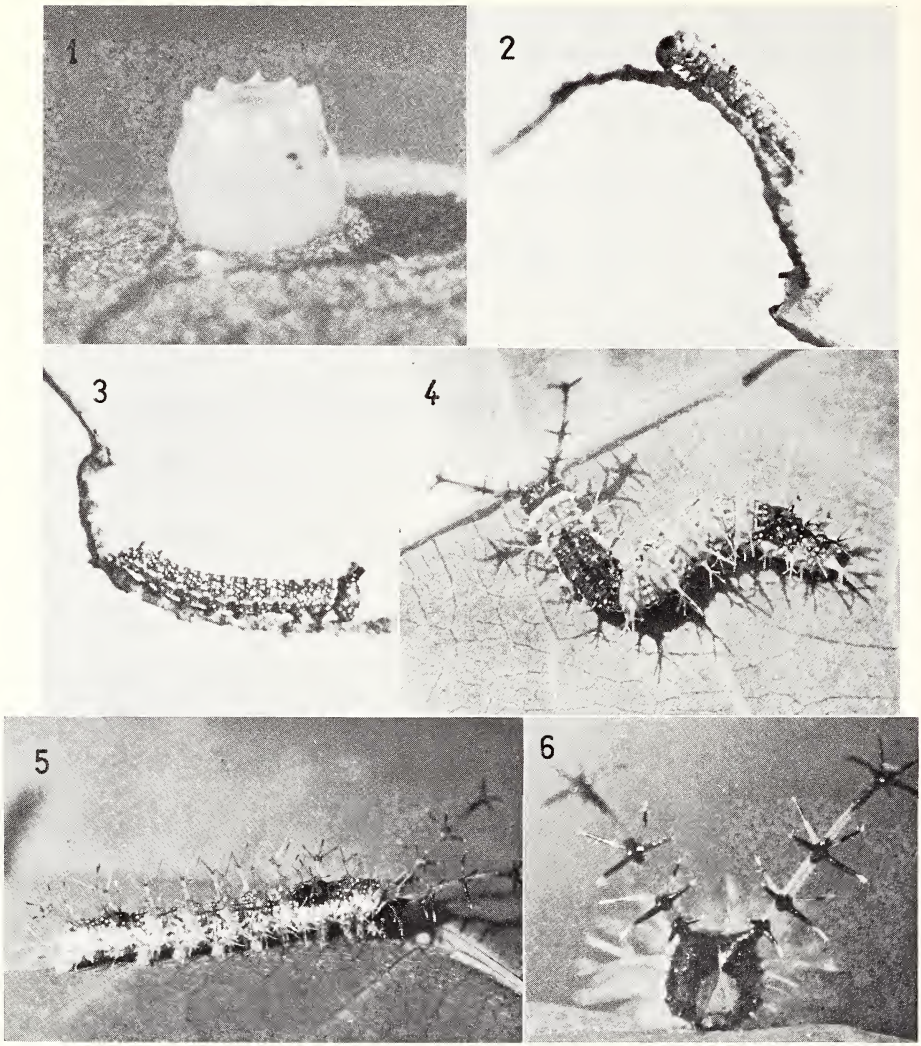
On September 8, 1969, my eldest son captured two identical and for us unknown larvae on a very broad-leaved tree known locally as "Tepeachote" (later identified as *Alchornea latifolia* Swartz). The larvae pupated the following day without feeding on the leaves on which they were found and produced, on September 19 and 20, two different butterflies, which were later identified as *C. numilia esite* male and female.

Assuming that the plant on which the larvae were found was the foodplant, weekly searches were made for them. On July 24, 1970, my eldest son again saw a female ovipositing on a tree of the same species in the neighborhood of Nuevo Cuscatlán, a village located about 8 km. southwest of San Salvador, capital of El Salvador. Nine eggs were collected then, put in individual transparent plastic bags, and brought back to our insectarium. Photographs were taken of the eggs and of the larvae that hatched from them until the adults emerged. Records of the time and measures of the different stadia were kept and specimens of the various instars and of the pupa were preserved in alcohol. During the whole process, the bags were under ambient light and temperature conditions. No moisture control was maintained, but the amount of moisture was high on account of the plastic bags, even if they were opened every day to clean them. Since that time we have reared this species many times, during different months of the year, except April and May, with about the same results. The specimens of the early stages and adults have been placed with the American Museum of Natural History, New York.

LIFE CYCLE STAGES

Egg. Truncated cone, about 1 mm. long and 1 mm. laterally at widest point. White with a bright yellow zone around the micropyle located on the center of the convexity tipping the egg. Around this convexity there is a crown of eleven thick and short prominences. From each prominence originates a vertical rib, of the same color as the rest of the egg, which reaches the base of the egg. They turn yellowish one day before hatching, which takes 4 to 5 days.

First instar larva. Head naked, dark brown, roundish, slightly thicker than body. Body dark green with caudal segments brownish-orange, naked with brown true legs. About 2 mm. when recently hatched and 5 mm. before moulting. 3–5 days.



FIGS. 1–6. *Catonephele numilia esite* Felder.

FIG. 1. Egg, about 1 mm. long.

FIG. 2. First instar larva ready to moult, on prolonged vein. Frass pellets can be seen stuck to body. About 5 mm. long.

FIG. 3. Second instar larva on prolonged vein. About 9 mm. long.

FIG. 4. Third instar larva with typical "S" attitude. About 1.2 cm.

FIG. 5. Fourth instar larva with straight attitude. About 2.3 cm.

FIG. 6. Fourth instar larva. Closeup of head.

Second instar larva. Head brown with white peppering. One stubby horn ending in a rosette of tiny spines on apex of each epicranium. Body olive-green dorsally, brown below spiracula, all mottled with white dots. Thoracic segments with four short branched white spines each. All abdominal segments with a transversal row of seven short, branched, white spines each, except the last two segments: the last one with only two lateral spines, the one before last with four lateral spines. It grows to about 9 mm. in 3–4 days.

Third instar larva. Head shiny black with white line around cervical triangle and long horns on epicranial apex, with three rosettes of spines each horn: the basal and median rosettes with four spines, the apical with five. Horns greenish with black zones at the base of the rosettes. Body olive-green with black areas dorsally from second thoracic segment to second abdominal segment, and from seventh abdominal segment caudad. Long forked spines cover the body now, following the same arrangement as in second instar. It grows to 1.2 cm. in 3–4 days.

Fourth instar larva. Same general aspect as in third instar, except for longer horns and orange-red areas on the head at the base of horns and in front. Thin spines at lateral margin of epicrania from base of horns to ocelli. It grows to 2.1 or 2.5 cm. in 4–6 days.

Fifth instar larva. Head mostly reddish-orange except lateral black margins of epicrania from base of black and green horns to mouth parts. Long and thin spines around margin of epicrania and shorter spines between horns. Body all green, mottled with white dots. Dorsal spines orange with black forks, the rest green with black forks. It grows to 4.2 cm. in 8–11 days.

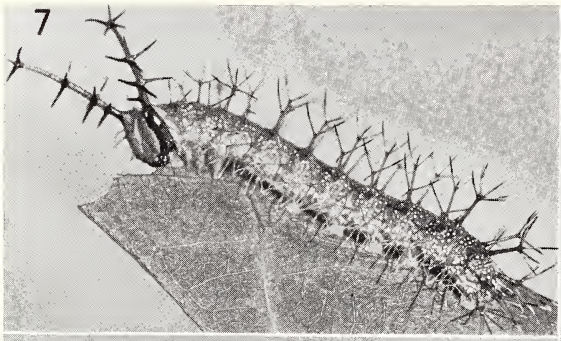
Prepupa. Much shorter and thicker, but same colors as fifth stadium. 2.5 cm. long. Duration, 1 day.

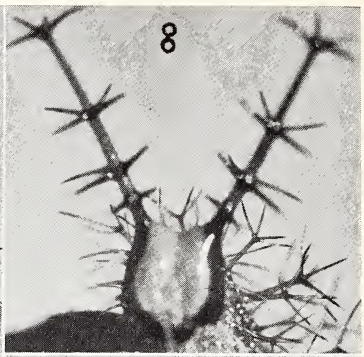
Pupa. Green of various shades, except for brown margin on wingcase on thoracic area, and small orange spiracula. Abdomen thickening gradually from cremaster to wingcase, then about the same thickness to thorax, separated from abdomen dorsally by indentation, then tapering gradually to bifid head. Cremaster has a flat base armed with crochets that permits the pupa literally to "stand" on the silken pad. Measures 2.3 or 2.8 cm. long, .9 or 1.0 cm. laterally at widest point, and .8 or .9 cm. dorsoventrally at widest point. Duration, 8–11 days.

Adult. Both sexes have about the same shape. Forewing with projected angle at apex, then sharp concavity (more so in females), then rounded convexity to tornus; inner margin straight. Hind wing rounded with outer margin slightly sinuose. Colors drastically different in males from females, dorsally.

Males. Dorsally basic color dark brown on both wings. Forewing with roundish orange zone at discal area, and smaller orange round spot at subapical zone. Hindwing with a squarish orange zone at discal area, a bluish zone at outer margin and a blue dot at anal angle. Ventrally both wings a combination of brown of different shades, from very light to very dark, except a yellowish area in forewing from basal to discal zones.

Females. Dorsally dark brown both wings as in male, but with four elongated yellow spots in line on discal area, and a line of two small yellow and one small reddish spots in subapical area. On the hindwing some bluish lines parallel to outer margin, from outer angle to anal angle. Ventrally combination of brown of different shades, darker than in males. There is a replica of the dorsal discal yellow spots on the forewing. Sizes average 6.0 cm. in males, 6.6 cm. in females, from tip to tip of spread forewings. Total developmental time varies from 34 to 47 days, females taking longer than males usually.





FIGS. 7–11. *Catonephele numilia esite* Felder.

FIG. 7. Fifth instar larva feeding at edge of leaf. About 4.1 cm. long.
FIG. 8. Fifth instar larva. Closeup of head.
FIG. 9. Prepupa on top of leaf. About 2.5 cm. long.
FIG. 10. Pupa lateral view. About 2.5 cm. long.
FIG. 11. Pupa dorsal view.

NATURAL HISTORY

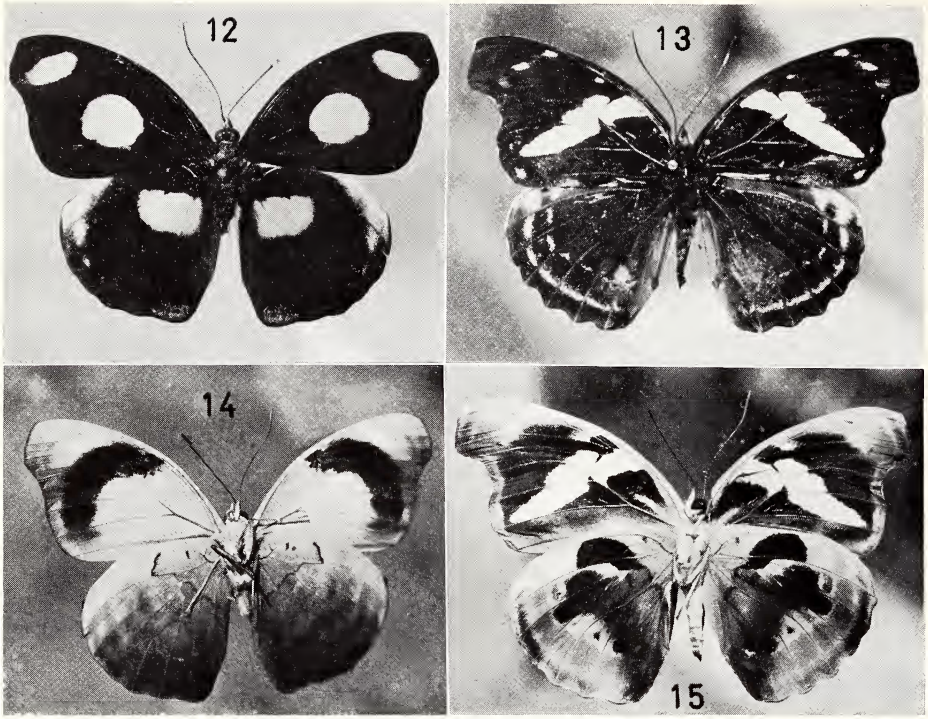
The foodplant of *Catonephele numilia esite*, *Alchornea latifolia*, is a medium-sized tree (up to 20 m. tall), locally called Tepeachote, with alternate, long-petiolate, broadly ovate, about 25 cm. long leaves with crenated margin; it belongs to the Euphorbiaceae family. The tree is found in coffee plantations where it is used, even if sparsely, as a shade tree and for its wood. Its range covers from 500 m. to 1500 m. of elevation.

The eggs of *C. n. esite* are deposited singly on the underside of mature leaves, mostly near the middle of the leaf, and even if the eggs are rather small, their white color contrasts against the green of the leaf, so they can be located with relative ease. At times more than one female oviposits one egg on a single leaf, so that more than one can be found on an individual leaf.

The recently emerged larvae eat the top of the eggshell and even part of the walls, but we have never seen them devour the eggshell completely. Shortly after feeding on the eggshell, the tiny larvae crawl to the edge of the leaf and start nibbling around the terminal of a vein until it is bare, and at the same time they affix the small frass pellets to it with silk, so that soon the vein seems to project beyond the leaf limits. To do this the larvae bend their bodies backward and with their mouthparts grab the pellet that is being expelled and then place it on the bared vein, weaving silk to affix it. It is not uncommon to find first and second instar larvae with several pellets of frass stuck with silk to their body. The larvae use this prolonged vein as a resting place at all moments while not feeding and during the first and second stadia, keeping the head pointing outward.

During the third, fourth, and fifth instars the larvae move about the plant, usually on the upper surfaces of the leaves, and, while resting, adopt two characteristic attitudes: one, the body straight, and two, the body "S" shaped. In both cases the head is bent forward so that the long horns are parallel to the leaf surface. If touched with a thin object the larvae strike suddenly with the horns with a back or side movement, depending on their physical position. Sometimes more than one larva move to the same leaf and accidentally touch another. When this happens the touched one reacts violently and strikes the offender with its horns, usually puncturing its body fatally; or both might strike simultaneously with similar results. We have found two larvae with their horns locked in such a way that they had succumbed to starvation. This might cause selection against any social habit.

When ready to pupate the larvae weave a silk pad, usually on the upper surface of the leaf, and affix to it their anal prolegs, keeping the body straight, resting on the leaf surface, the horns upraised or bent forward. Shortly before doing so they clean the digestive tract by ejecting an amount of green liquid mixed with excrements.



FIGS. 12–15. *Catonephele numila esite* Felder.

FIG. 12. Male, dorsal view. About 6 cm. from tip to tip of spread forewings.

FIG. 13. Female, dorsal view. About 6.5 cm from tip to tip of spread forewings.

FIG. 14. Male, ventral view.

FIG. 15. Female, ventral view.

The pupae, due to their relatively large, flat surface armed with crochets on their cremaster, keep themselves "standing" at an angle on the upper surface of the leaves. Sometimes they seem to hang when the supporting surface is the underside of a leaf or a twig, but if the object is turned over it becomes evident that the pupae are not hanging, but standing on it, as they maintain the same angle regardless of the object's position. There are times when the pupae get punctured by their own exuvia in the process of affixing the cremaster to the silken pad and disposing of the crumpled larval skin. The pupae when molested respond with violent lateral swings or move in an accordionlike fashion. In both cases they produce a faint, but audible, squeaking sound somewhat like that of cerambicid beetles.

The adults of this species emerge rapidly from the pupa shell and walk to a surface from which they can hang, and in about 15 minutes their wings are rigid and ready to fly. During this process they eject an amount of reddish meconium.

We have dissected recently emerged females and none of them had eggs in their abdomen.

Both sexes are strong flyers. Males favor treetops where they can be seen standing alertly and darting swiftly to chase other males of the species, but they permit other species (mostly *Anaea* spp.), to use their chosen treetop without attacking them. Females are seen flying at lower levels and alighting on tree trunks with their heads pointing downward. The females are slightly larger than males.

Recently emerged couples have been kept in a cage for as long as 10 days, feeding on fermenting banana, without obtaining copulation.

When ready to oviposit the females fly around the chosen tree a few times, alight on the underside of a mature leaf, near its middle, deposit one egg thereon, and immediately resume flying. They repeat the process some eight to ten times before departing. Oviposition occurs usually between 10:00 and 14:00 hours.

In the fields both sexes feed greedily on a variety of fermenting fruits, usually on the ground, and on animal excrements. While feeding they lose their alertness and can be netted with facility. We have never seen adults of this species on flowers.

We have found eggs of *C. numilia esite* the year around but mostly during the rainy season (May to October).

DISCUSSION

J. Röber (1914) described very well the fifth instar larva and the pupa of *Catonephele numilia* and reported the foodplant, in South America, to be *Alchornea iricura* Cas. and *A. cordata* Müller Arg. However, apparently this is the first complete life history description with photographs of this species.

Ebert (1969) groups under Catonephelinae other genera besides *Catonephele* (*Cybdelis*, *Epiphile*, *Myscelia*, and *Temenis*), some of which are represented in El Salvador lepidopterous fauna, plus others: *Pyrrhogyra* and *Pseudonica*, whose eggs, larvae, pupae, and behavior during the early stages are so similar to that of *Catonephele numilia esite* that we do not hesitate to group them together. We even dare to suggest that the genus *Pyrrhogyra* probably is the intermediate between Catonephelinae and Callicorinae, because the eggs of *Pyrrhogyra* are more like the later group than *Catonephelinae*, although the larvae are not. Ebert (loc. cit.) groups the genera *Callicore*, *Diaethria*, and *Paulogramma* under Callicorinae. (We add, for the same reasons as above, the genus *Catagramma*.) If the characteristics of the early stages and their behavior mean anything, it is evident that the two groups are at least very closely related.

In addition to *C. numilia esite*, we have reared from egg to adult *Epiphile*

adrasta adrasta Hewitson (manuscript in preparation), *Temenis laothöe liberia* Fabricius (manuscript in preparation), *Pseudonica flavilla canthara* Doubleday, *Pyrrhogyra hypsenor* Godman & Salvin of the Catonephelinae group, and *Diaethria astala* Guérin and *Catagramma titania* Salvin of the Callicorniae, besides other species we have studied incompletely that belong to either group. From this experience we agree with Holland (1914) that "species which are related to one another show their affinity even in the form of their egg," and with Brower, Brower, and Collins (1963) on "... characters on which the forces of centripetal selection resist change to a greater degree. Classically these are the external morphological characters of the eggs, larvae, pupae and adults." ... This criterion is reinforced by the similarity of the behavior of the immature stages of the mentioned species belonging to the two groups, which, according to Crane (1957), is an important factor in determining phylogenetic relationships. This will become most apparent as the following articles of the intended series are presented.

The first and second instar larva of *C. numilia esite* and the other species mentioned behave similarly in the way the eggshell is eaten: Just the upper part of it and sometimes part of the wall are consumed by the recently emerged larvae. Again, all of them have the same habit of moving to the edge of the leaf, nibbling around a vein, prolonging it with frass stuck with silk, and using this vein as a resting place while not feeding.

Catonephele n. esite and others use the bared vein as described during the first and second instars only, while others use it even during the third stadium. All of them, during the fourth and fifth instars, wander about the upper surface of the leaves, and, when resting, adopt the same attitudes: the "S" shaped and the straight ones, with the head bent forward to keep the horns parallel to the leaf surface. Besides the behavioral similarities there are striking morphological ones: First and second instars can very easily be taken for one another. From the third stadium on, there are differences not only in coloration but in the spines that cover the body: They are more or less abundant or almost lacking, but the head and its horns keep the same pattern. The pupae of all these species also have the same general aspect with minor differences; all of them have the cremaster with the flat surface that permits them to "stand" on the leaf; and all of them produce the defensive sound when molested. Only three of the local species included in the Catonephelinae group show a drastic sexual dimorphism when adults: *Catonephele numilia esite*, *C. nyctimus* Westwood, and *Epiphile adrasta adrasta*. In the Callicorinae only the *Diaethria* spp. show a certain sexual dimorphism. We have then a consistent similarity of basic morphological characteristics and of behavior during the early stages, and some adaptive differences in some of the adults.

In relation to the foodplants used by the two groups, only two Catonepheli-

nae, *C. n. esite* and *C. nyctimus,* were found on Euphorbiaceae. All the rest of the Catonephelinae and all of the Callicorinae of the local fauna were found exclusively on several species of Sapindaceae; this is another factor in common between the two groups.

During the several years we have studied *Catonephele numilia esite* in our insectarium the only cause of mortality we have noticed, besides the larval fights, as been a diarrhea that provokes a softening of the body tissues and inevitably ends in death of the larvae by bursting of the body. This always happened when the larvae were fed on slightly decaying leaves of the foodplant.

In the fields many first instar larvae die of desiccation during the dry season, mostly when the trees are located near dirt roads and the leaves are covered by a heavy layer of dust. Up to the present we have not found any cases of parasitism in this species.

C. n. esite shows a cryptical defense mechanism during some of the early stages (first and second instars), very similar to the one used by Charaxinae (Muyshondt 1973 A, B, and C), when the young larvae on the bared vein imitate portions of leaf tissue still attached to it. The pupae also might be considered mimetic by their green color, even if they are usually standing on top of the leaves and not hidden under them. But third, fourth, and fifth instar larvae of this species seem to rely rather on the mechanical defense provided by the long horns on the head and the profusion of forked spines that cover the body. These spines are not urticant, but very sharp. The adults, even if they are strong flyers, use the flash and hide effect obtained from their showy dorsal colors contrasting with the cryptical brown of their underwings. A puzzling aspect of the adults of *C. numilia esite* is the drastic difference in dorsal coloration between the two sexes for no apparent benefit. None of the two sexes mimics any of the classically considered "protected" species of the local fauna pertaining to the Danaidae, Heliconiidae, Ithomiidae or Papilionidae.

The defensive strategy of *C. n. esite* is quite complex; it at times points to a palatable condition for predators, as would be a logical consequence of the lack of aromatic or bitter compounds in the foodplant used by the larvae, *Alchornea latifolia,* but then during other phases of development suggests protection by unpalatability, manifested by the rather showy colors the larvae display and their way of resting exposed on the tops of leaves. This peculiarity of behavior made us wonder about the qualities of the foodplant. It is known that many Euphorbiaceae contain not only violent poisons but terribly caustic juices (Planchon and Collin, 1895). Others apparently produce hydrogen cyanide (Brower and Brower, 1964). It would be interesting to investigate the foodplant of *C. n. esite* for deleterious components that could be accumulated in the body of the feeding larvae, becoming concentrated gradually and starting to function as predator-deterrents after the larvae

reach a certain state of development, in this case the third instar. Such an investigation of the foodplant might therefore explain the change of behavior.

Literature Cited

BROWER, L. P. AND VAN ZANDT BROWER, JANE. 1964. Birds, butterflies and plant poisons: A study in ecological chemistry. Zoologica, **49**: 3.

BROWER, L. P., VAN ZANDT BROWER, JANE, AND COLLINS, C. T. 1963. Experimental studies of mimicry. 7. Relative palatability and Müllerian mimicry among neotropical butterflies of the subfamily Heliconiinae. Zoologica, **48**: 7.

CRANE, JOCELYN. 1957. Imaginal behavior in butterflies of the family Heliconiidae: Changing social patterns and irrelevent actions. Genetics, **47**: 909–920.

EBERT, HEINZ. 1969. On the frequency of butterflies in eastern Brazil, with a list of the butterfly fauna of Poços de Caldas, Minas Gerais. Jour. Lep. Soc., **23**: Sup. 3.

FORD, E. B. 1945. "Butterflies." Collins, London.

HOLLAND, W. J. 1914. "Butterflies." Doubleday, Page & Co., New York.

KLOTS, ALEXANDER B. 1960. "A Field Guide to the Butterflies." Riverside Press, Cambridge.

MUYSHONDT, A. 1973. A. Notes on the life cycle and natural history of butterflies of El Salvador. I. *Prepona omphale octavia* (Nymphalidae). Jour. Lep. Soc., Vol. **27**.

———. 1973. B. Notes on the life cycle and natural history of butterflies of El Salvador. II. *Anaea* (*Zaretis*) *itys* (Nymphalidae). Jour. Lep. Soc., in press.

———. 1973. C. Notes on the life cycle and natural history of butterflies of El Salvador. III. *Anaea* (*Consul*) *fabius*. Jour. Lep. Soc., presented for publication.

PLANCHON, G. AND COLLIN, E. 1895. Les Drogues Simples d'Origin Végétale. Octave Dion, Paris.

RÖBER, J. 1914. *In* Seitz, "Macrolepidoptera of the World." Vol. **5** Stuttgart.